



Dredging Research Technical Notes



Construction and Monitoring of Nearshore Placement of Dredged Material at Silver Strand State Park, San Diego, California*

Purpose

This Technical Note describes the construction and monitoring of nearshore placement of dredged material at Silver Strand State Park, in San Diego, California.

Background

Within the Los Angeles District, most maintenance dredging material is placed on beaches adjacent to the harbors from which the sand has been dredged. In a few instances, dredged material is placed offshore at interim ocean placement sites. However, in 1988, the Los Angeles District implemented the first recent nearshore placement project on the west coast of the United States during the maintenance dredging of San Diego Harbor.

Additional Information

This Technical Note was written by Mr. Leonard Juhnke of Manson Construction and Engineering Company in Seattle and Messrs. Thomas Mitchell and Michael J. Piszker of the US Army Engineer District, Los Angeles. The authors

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thank the Los Angeles District project team members for their efforts in several aspects of this project. Thanks also go to the captain and crew of the *Newport* for fulfilling the contract in both a timely and a safe manner. Chris Butcher of Tekmarine, Incorporated, provided the profile data shown in this note. Special thanks go to Ms. Joan Pope, US Army Engineer Waterways Experiment Station; Mr. Steve Dwyer, Los Angeles District; Mr. David Patterson, Los Angeles District; and Mr. Mike Ellis, formerly of the Los Angeles District and now with Connolly-Pacific Company. For additional information, contact the Technical Area Manager, Dr. Nicholas C. Kraus, (601) 634-2018, or the manager of the Dredging Research Program, Mr. E. Clark McNair, (601) 634-2070.

Introduction

San Diego Harbor is the southernmost harbor on the west coast of the continental United States. It is also one of the larger ports on the west coast, serving several large industries, the US Navy, and the City of San Diego.

In 1988, the dredging project was in the outermost nautical mile of the entrance channel to San Diego Harbor. The placement site was off Silver Strand State Beach approximately 6 miles southeast of the dredging location. The dredging and placement sites are shown in Figure 1.

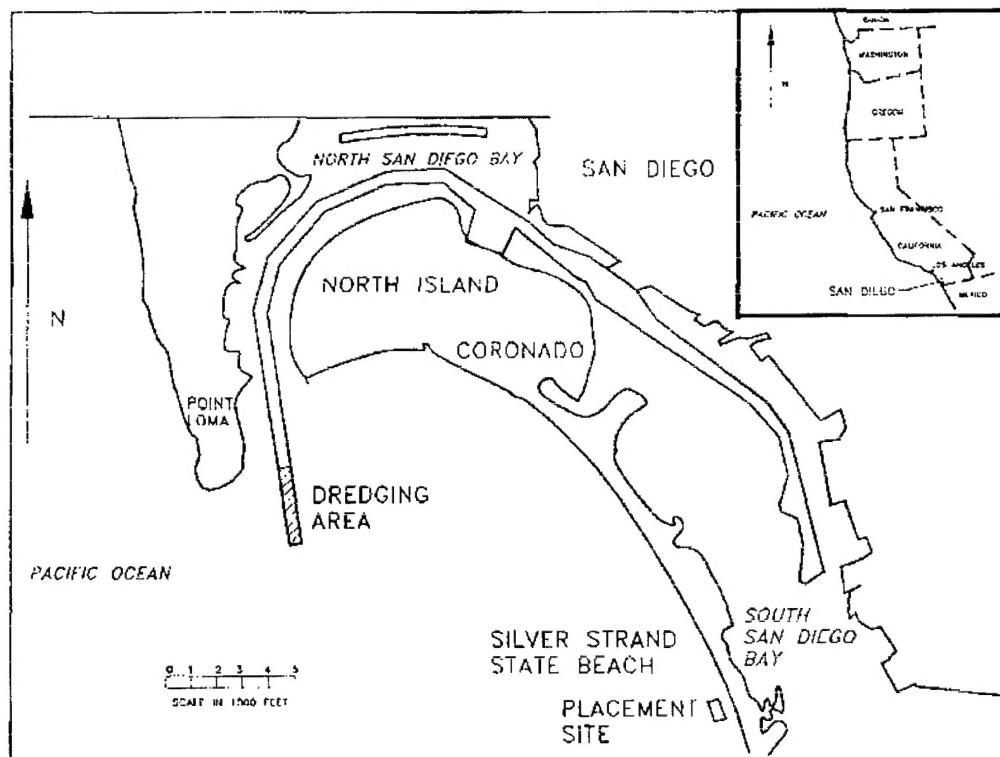


Figure 1. Project sites and vicinity map

Engineering and Design

Nearshore placement is a technique which, if designed properly, can renourish a beach or prevent further erosion of a beach by offering storm protection. The features resulting from this technique are often referred to as Murden's Mounds, after Mr. William Murden, former chief of the Corps Dredging Division and champion of the technique. Although nearshore placement has been conducted on the east and Gulf coasts, this was to be the first implementation of this concept on the west coast since a project in Santa Barbara in the 1930s (McLellan, Truitt, and Flax 1988).

In a typical beach placement operation, a hydraulic dredge pumps a slurry mixture through a pipeline and places material directly onto the beach, sometimes behind a dike. In a nearshore operation, material is placed offshore of the beach to create an artificial bar which has a shore-parallel alignment. If designed properly, the material in the artificial bar will be set in motion by waves and migrate onto the beach adjacent to the placement site or move into the littoral zone where the sand will be transported to upcoast or downcoast beaches. The two typical placement scenarios are shown in Figure 2.

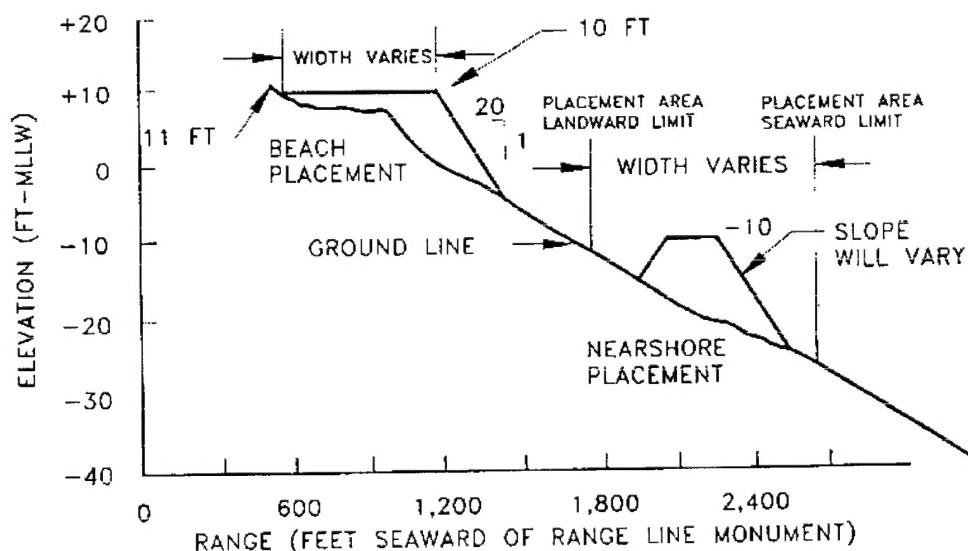


Figure 2. Beach placement versus nearshore placement

Depending on the distance between a project dredging area and the placement site, use of the nearshore concept can assist the Corps in providing a more economical placement alternative. Nearshore placement can also assist the Corps in following the Federal Standard, which requires the use of the most economical means of placement which is environmentally acceptable.

In the San Diego project, with a hauling distance of 6 miles, the estimated cost for transporting the sand, by means of a hydraulic pipeline dredge, to the beach adjacent to the nearshore placement site was nearly twice the estimated cost of nearshore placement. The Los Angeles District fulfilled the Federal Standard

because the placement site was the closest to the dredging area and subsequently least costly which met approval of all involved resource parties.

At San Diego, the placement site was 1,200 ft in the longshore direction and 600 ft in the cross-shore direction. The onshore and offshore limits were about 800 and 1,400 ft offshore, respectively, which were the approximate locations of the -10 and -30 ft Mean Lower Low Water (MLLW) contours. The estimated dredging quantity, 91,000 cu yd, divided by the longshore length of the placement site, 1,200 ft, yielded the design relation for the Silver Strand disposal site of 75 cu yd of sand per ft of shoreline.

To best assure that sand in the nearshore placement site will be set in motion by waves, the sand should be placed above the depth of closure. Depth of closure is defined by the Coastal Engineering Research Center (Shore Protection Manual 1984), as the seaward limit to extreme surf-related effects throughout the typical year, and is calculated as follows:

$$d_1 = 2 H_{S50} + 12 S_H$$

where H_{S50} = median annual significant wave height
 S_H = standard deviation of significant wave height

The equation is based on work done by Hallermeier (1981) for waves over quartz sands and is a good empirical approach to design. However, in disposal locations where repetitive profiles are available, depth of closure can be obtained in a more practical manner by analyzing the profiles. The seaward limit at Silver Strand was estimated at -33 ft based on the use of repetitive profile data.

Material deposited in the entrance of San Diego Harbor is generally sand eroded from upcoast cliffs and downcoast beaches. Sampling was conducted in both the dredging area and the placement site before development of plans and specifications for the project. A compatibility analysis was conducted for the nearshore placement project as would be done in most beach placement projects. The median grain size of the native (placement site) material was approximately 0.25 mm with approximately 6 percent passing a No. 200 sieve. The median grain size for the fill (placement material) was estimated at 0.18 mm with less than 12 percent passing a No. 200 sieve.

The project specifications also required that sampling of the dredged material be conducted by the dredge contractor (one for each hopper bin or placement cycle). A size analysis of the 120 samples collected during the project has not yet been conducted.

For dredging projects in California, a Coastal Consistency Determination must be submitted to the California Coastal Commission for review in determining whether a project is in accordance with the California Coastal Act of 1976. Among other things, the Act views clean sand as a resource and requires that this resource not be wasted, that is, placed offshore. Therefore, every effort must be made to place the sand as close to shore as possible to best assure its landward transport.

Some locations may be constrained by water quality regulations governing turbidity levels. The San Diego project was issued a waiver by the local board. Observations during the project did not show an excessive turbidity plume adjacent to the dredge at the time of placement.

An important consideration in designing and scheduling a nearshore placement job is the weather, and more specifically, surf conditions. In discussions with various contractors before setting up the contract, most owners of split-hull hopper dredges or dump scows indicated that they would not mind placing their equipment so close to shore that they actually touched bottom, assuming there are little to no waves. However, when the surf is large enough to move the vessel vertically, there is concern for the structural safety of the vessel. With a split-hull hopper or scow open, much stress is put on the hinge which holds the two hulls together when the vessel bounces off the bottom due to wave motion. This is a major safety hazard. Ideally, nearshore placement operations should only occur when the surf is less than 3 to 4 ft.

Dredging

A contract was awarded to Manson Construction and Engineering Company of Seattle on August 26, 1988. The contract was based on a bid mobilization and demobilization of \$300,000, and a unit price of \$2.38 per cu yd for dredging 91,000 cu yd, for a total contract price of \$516,580. A slight overrun resulted in a final pay quantity of 97,470 cu yd for final contract cost of \$531,978.60. The effective unit price for the entire project was \$5.46.

Manson did the entire project with their *Newport*; a 4,000-cu yd split-hull trailing suction hopper dredge. The *Newport* is 265 ft long with a beam of 55 ft. Empty, the *Newport* draws only 6 ft; fully laden it draws 17 ft. However, during the San Diego project, the dredge's hopper bin was never filled to capacity during any of its 120 dredging cycles. The maximum draft experienced during the project was 15 ft.

The nearshore placement concept is not limited to hopper dredging operations. The concept could be implemented by use of a clamshell dredge with split-hull dump scows or a pipeline dredge with turbidity-controlled discharge.

Dredging began on December 7, 1988 and continued through December 18. Dredging resumed on January 4, 1989 after an interim postdredge survey revealed the need for the contractor to remove a few spots within the channel. Dredging ended on January 7.

Based on predredging and postdredging surveys, approximately 130,000 cu yd of beach-compatible sand was dredged from the entrance channel. This included the pay quantity of approximately 97,000 cu yd and material removed from outside the pay prism. This difference is largely due to the fact that there was no pay overdepth allowance in the contract. Contract depth was -44 ft. Material

placed in the nearshore zone based on the contractor's bin measurements was 190,000 cu yd.

Placement

Before placement of dredged material, four buoys were placed to mark the corners of the disposal area. During all placement cycles, the hopper dredge *Newport* approached the placement area perpendicular to the shore with the bow and hopper forward of the dredge's bridge and propellers. The position of the dredge was determined through use of an Electronic Positioning System (EPS). When the EPS showed the vessel inside the placement area, the dredge stopped and the split-hull hopper was opened to allow placement of the dredged material. Reports from the master indicate the dredge touched bottom twice during the entire operation.

Of major concern to the Corps is quality assurance and specifically placement locations. The project specifications required that the contractor use an EPS during disposal operations. The *Newport* is equipped with a Micro Fix (Racal) EPS and uses a Grady Bryant navigation program with a Hewlett Packard computer to provide positioning on a Houston Instruments plotter. In addition to the track plotter, a printer was activated during placement which furnished X and Y coordinates on a real-time printout at 30-sec intervals. Time of placement was noted on the printout by one of the ship's mates. All information was furnished to the Corps' Quality Assurance Representative.

The EPS provided the data plotted on Figure 3, which shows the location of the dredge at each of the 120 placement cycles. Below the scale is a template drawn to scale of the dredge *Newport* with a dot showing the location of the ship's EPS radio

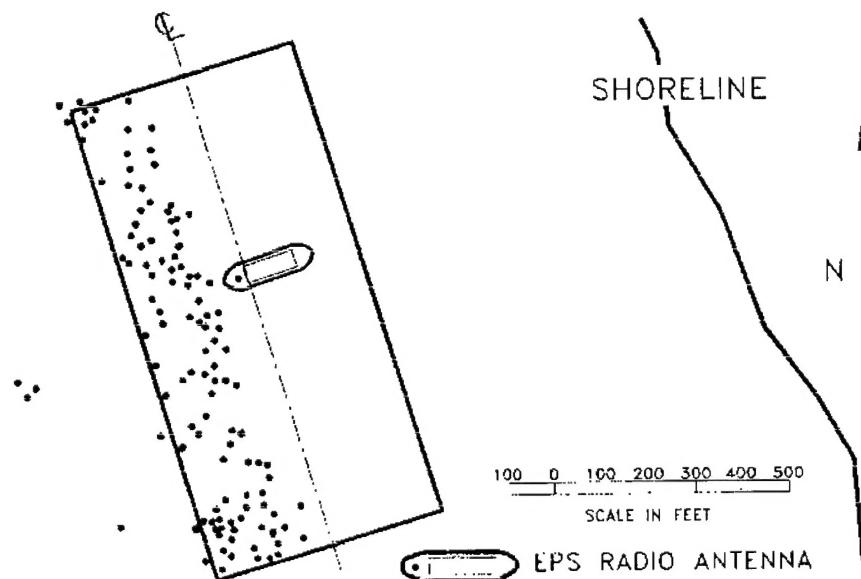


Figure 3. Hopper dredge EPS-based placement locations

antenna near the stern of the vessel above the bridge, and the location of the hopper bin near the center of the vessel. With the template superimposed on each of the dots, the figure shows a vast majority of the placement cycles resulted in placement of sand near the precise cross-shore centerline of the placement limits.

Monitoring

Because the concept of nearshore placement is in its early stages, it is important to gather as much data on the concept in order to help determine its feasibility. Los Angeles District personnel were encouraged by US Army Engineer Division, South Pacific and Headquarters, US Army Corps of Engineers personnel to monitor the placement site. Hence, a contract to monitor the placement site was awarded to Tekmarine, Incorporated, a Pasadena, California, based coastal engineering firm.

The monitoring program included repetitive surveys and the temporary deployment of a directional wave gage near the placement site which will be used to correlate beach changes with the wave climate. Aerial photography has also been conducted in order to assess changes to the shoreline. The monitoring program schedule is shown in Table 1. The program did not include sampling of the dredged material after placement at the placement site.

Table 1. Monitoring Program

Date	Task
8-9 December 1988	Preplacement survey
22 December 1988	Wave gage installed
28-29 December 1988	Postplacement survey
19-20 January 1989	Monitoring survey 1
15-16 February 1989	Monitoring survey 2
15-16 March 1989	Monitoring survey 3
17-18 May 1989	Monitoring survey 4
18 May 1989	Wave gage removed
14-15 August 1989	Monitoring survey 5
14-15 November 1989	Monitoring survey 6
April 1990	Monitoring survey 7 (planned)

The location of the directional wave gage and the eight profile lines surveyed as part of the monitoring program, relative to the placement site, are shown in Figure 4.

Tekmarine used both land- and water-based survey methods. During a survey, a rodman in a wetsuit walks the beach and into the water up to 10 ft deep. Surveying on days of calm seas allows the hydrographic survey vessel to come fairly close to shore and overlap several of the points recorded with the rodman.

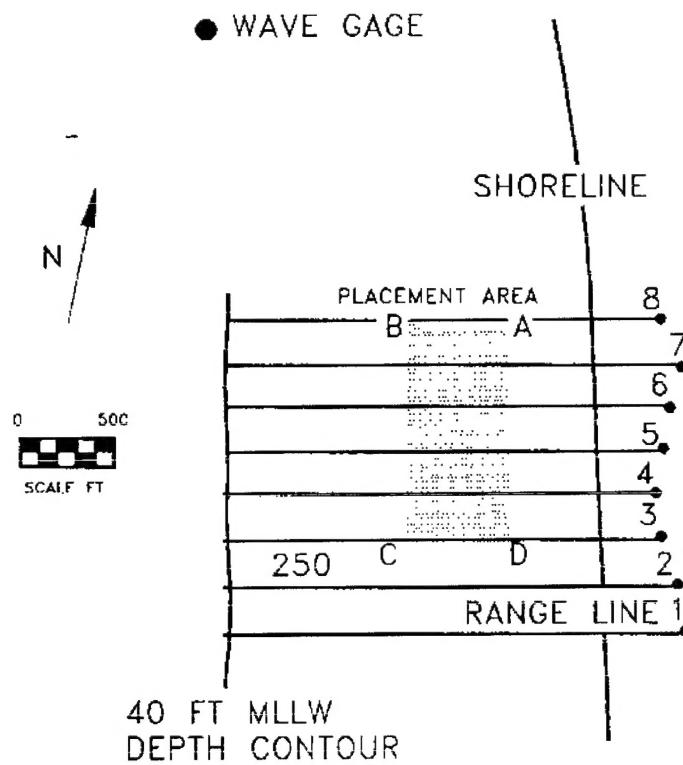


Figure 4. Location of wave gage and range lines

Tekmarine is developing three types of profile plots. One type shows data recorded along one profile line on one day. Figure 5 shows profile line 6 as it appeared on January 19, 1989. Note the overlap of the land-based surveying points (triangles) and water-based surveying points (smooth line).

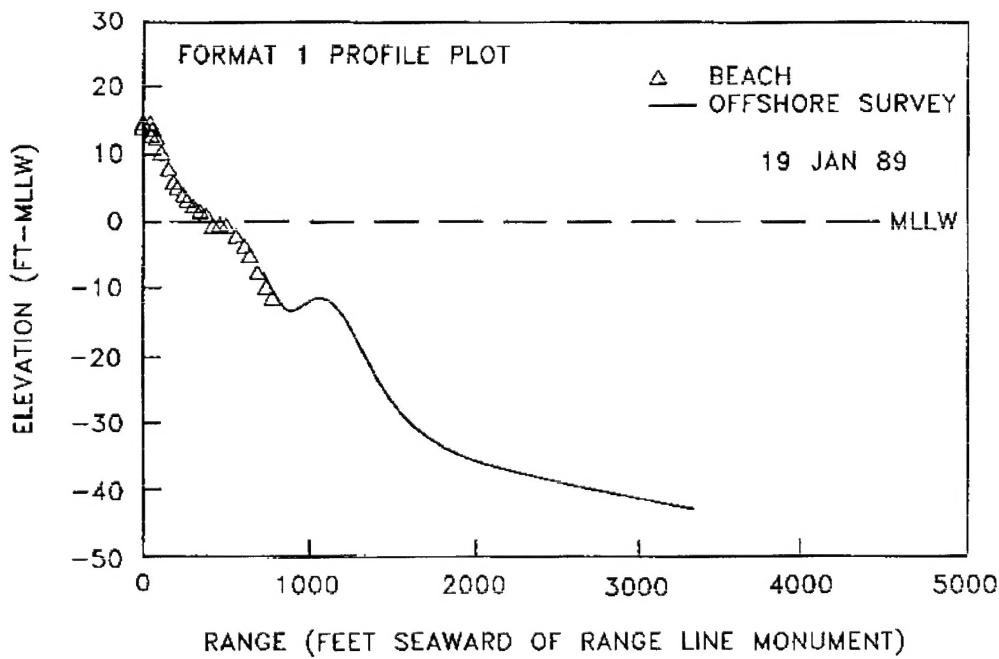


Figure 5. Range line 6 as surveyed on January 19, 1989

The second type of plot shows a comparison of several different surveys along the same profile line. Figure 6 shows a plot of line 5, which runs through the middle of the placement site, with a preplacement profile, a postplacement profile, and two of the more recent interim surveys. This figure shows that the crest elevation of the offshore bar was raised from -15 ft to -10 ft during the placement operations and that the sand from the artificial bar is migrating landward.

The third plot provided by the monitoring program is a comparison of only the beach data. Figure 7 again shows data from line 5, but with more detail of the shoreline. The shoreline has moved seaward almost 200 ft since before the project began.

Figure 8 shows range line 1, which is south of the placement sites limits by 500 ft. The shoreline here has moved seaward over 100 ft.

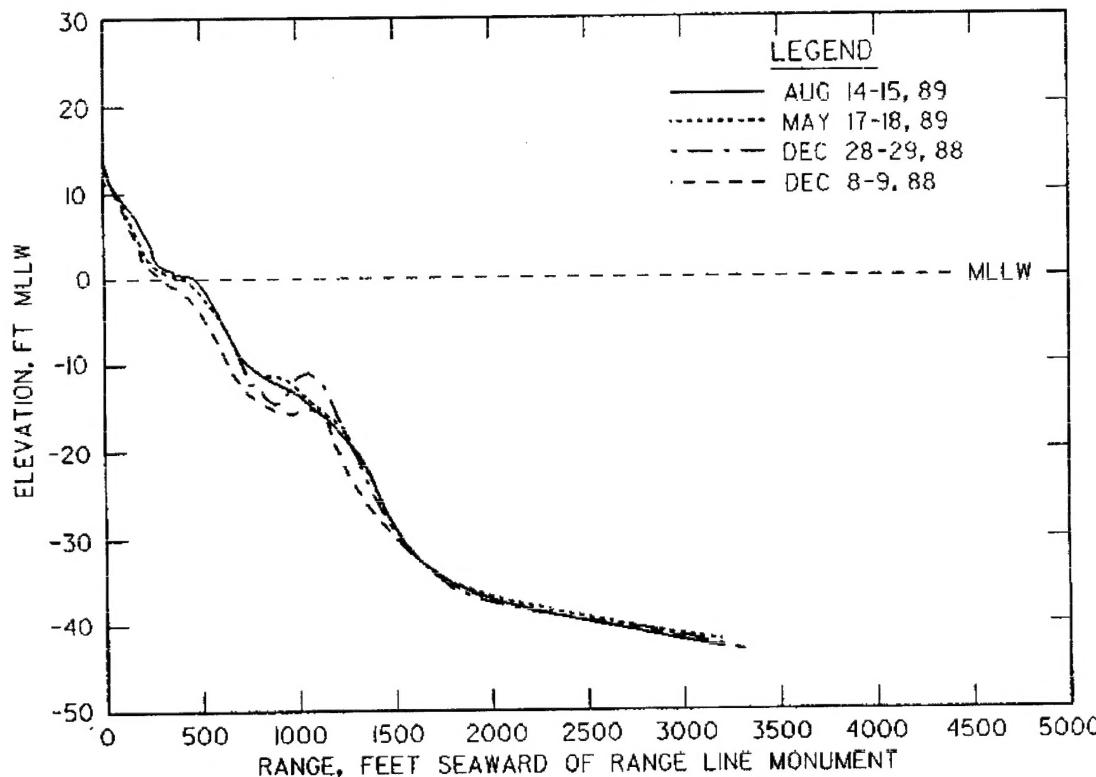


Figure 6. Range line 5 repetitive profiles

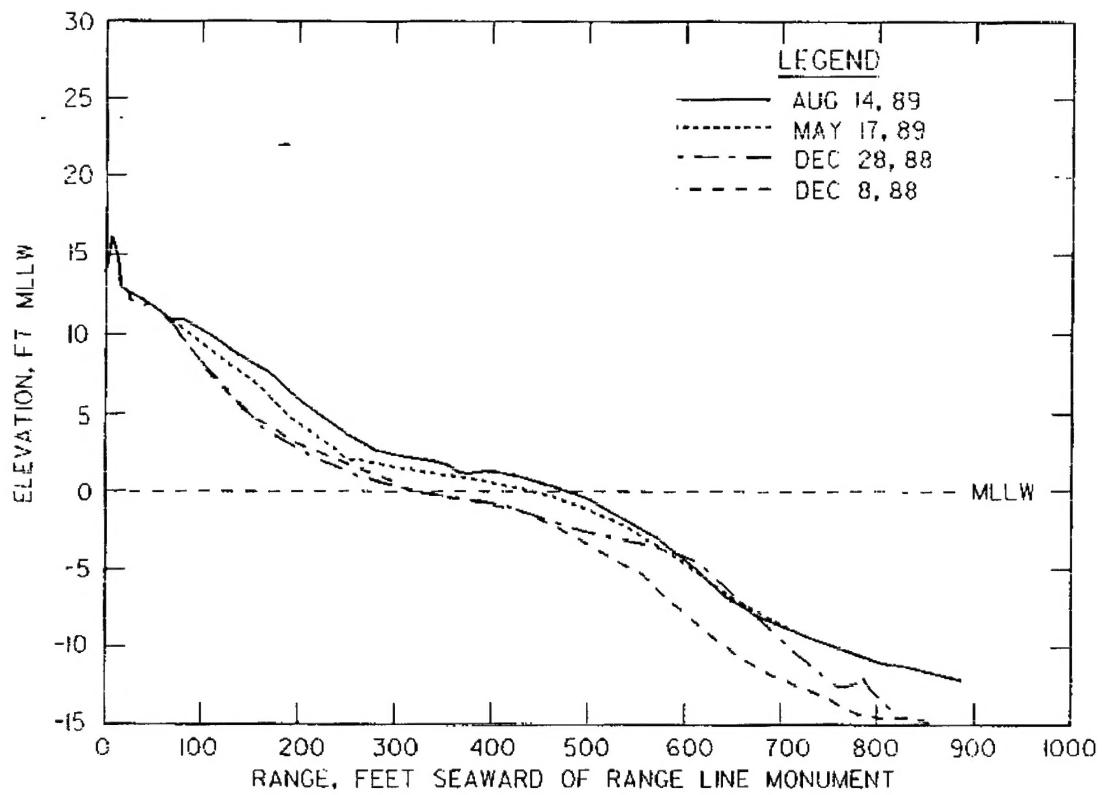


Figure 7. Range line 5 repetitive beach data

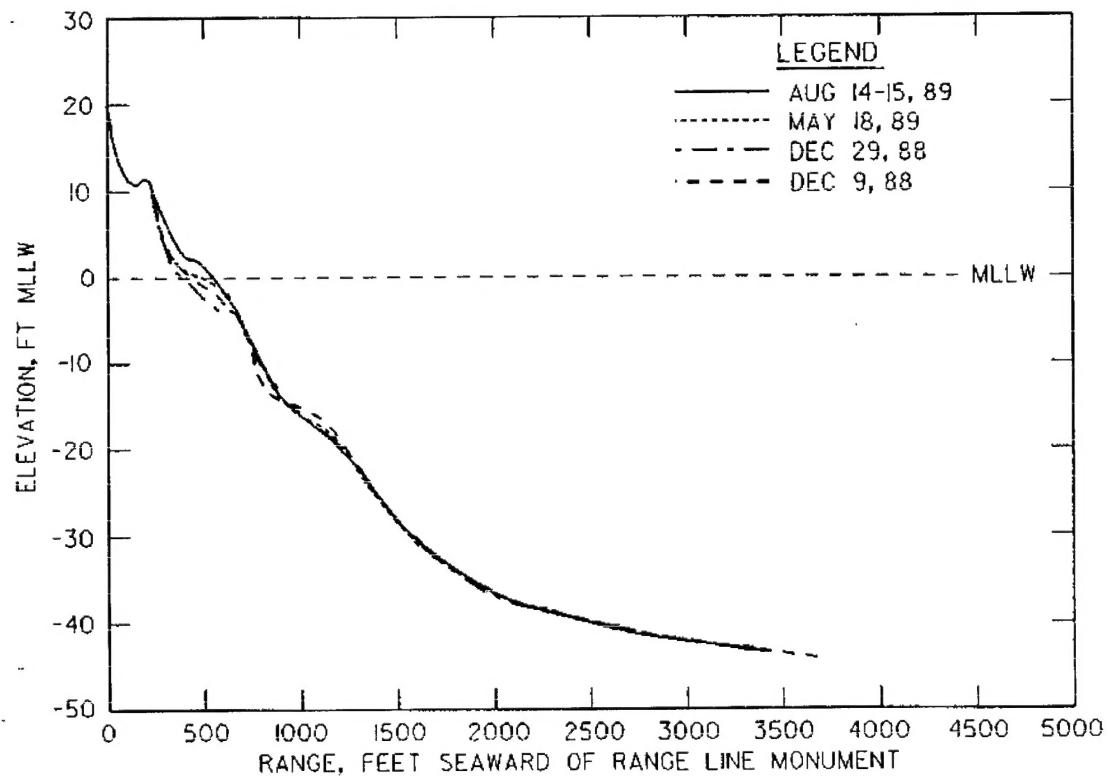


Figure 8. Range line 1 repetitive profiles

Conclusions

The monitoring contract was completed in April 1990, and the Los Angeles District plans to publish final results of the entire program. The results should aid in determining the feasibility of sand supplied to the beach in this manner. Incidentally, the project has also produced the benefit of enhanced surfing conditions, as indicated by the overwhelming good press on the subject printed in local newspapers.

For the Los Angeles District, the maintenance dredging and nearshore placement at San Diego has led to the preliminary conclusion that nearshore placement, if designed properly, can be performed safely with cost savings and benefits to the coastal environment.

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